A LANDSCAPE INDICATOR-SYSTEM FOR SUSTAINABLE LANDSCAPE MANAGEMENT

FENNTARTHATÓ TÁJGAZDÁLKODÁST SZOLGÁLÓ TÁJINDIKÁTOR-RENDSZER

SZERZŐ/*BY:* ISTVÁN VALÁNSZKI, ÁGNES SALLAY

INTRODUCTION AND LITERATURE REVIEW

The landscape values and landscape potential can be the base of rural development. The long-term and balanced utilization of these opportunities is possible through sustainable landscape management. Several researches[1,2,3,4] have clearly defined the correlation between social welfare and ecosystem services/landscape functions, but especially in case of the life quality of the rural population we consider the wide range and complexity of landscape services extremely important. The Hungarian rural regions have got very different characteristics, that is why properly targeted and specified programs, strategies are needed to develop them in an appropriate way.

Authors, planners and researchers emphasized that the first step of sustainable landscape management is landscape-function analysis. [5,6] The terms of ecosystem services and

1 *Norgaard, R. B. (2010): Ecosystem services: from eye-opening metaphor to complexity blinder. Ecol. Econ. 69, 1219–1227. DOI: http://doi.org/10.1016/j.ecolecon.2009.11.009*

2 *Hubayné Horváth, N. (2015): Sikeres tájgondozási modell Németországban. A successful landscape management model in Germany. 4D Tájépítészeti és Kertművészeti Folyóirat (40) pp. 2-13.*

3 *Illyés, Zs. (2015): Tájgondozás, mint a tájvédelem helyi eszköze. Landscape management as a local tool for landscape protection. 4D Tájépítészeti és Kertművészeti Folyóirat (40) pp. 14-23.*

4 *Kollányi, L., Dancsokné Fóris, E., Máté, K. (2015): Tájgondozás, örökségvédelem a világörökségi területek védelmében. Landscape management and heritage protection for Word Heritage Sites. 4D Tájépítészeti és Kertművészeti Folyóirat (40) pp. 24-31.*

5 *de Groot, R. S., Alkemade, R., Braat, L., Hein, L. és Willemen, L. (2010): Challenges in integrating the concept of ecosystem services and values in landscape planning management and decision making. Ecological Complexity 7, 260–272. DOI: http://doi.org/10.1016/j.ecocom.2009.10.006*

6 *Hermann, A., Kuttner, M., Hainz-Renetzeder, C., Konkoly-Gyuró, É., Tirászi, Á., Brandenburg, C., Allex, B., Ziener, K., Wrbka, T. (2014): Assessment framework for landscape services in European cultural landscapes: An Austrian Hungarian case study. Ecological Indicators 37 (A), 229–240. DOI: http://doi.org/10.1016/j.ecolind.2013.01.019*

7 *Ehrlich, P. R. and Ehrlich, A. H. (1981): Interaction Among Landscape Elements: A Core of Landscape Ecology, New York: Random House*

8 *Costanza, R., Arge d', R., Groot de, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P., Belt van den, M. (1997): „The Value of the World's Ecosystem Services and Natural Capital". Nature, 387: 253– 260.*

9 *MEA (Millennium Ecosystem Assessment) (2005): Ecosystems and hu-man well-being: Biodiversity synthesis. World Resource Institue, Washington D.C., 86 p.*

landscape functions are very popular in landscape ecology research, landscape planning and open space design. Since decades experts realized that the welfare of the society depends on nature. The two concepts which have similar meaning but different focus have been evolved parallel to each other in the literature. For the first time Ehrlich and Ehrilch[7] used the term of ecosystem services and later Costanza et al. was dealing with the economic assessment of ecosystem services in 1997.[8] The most important turning point was the publication of the results of the international research program Millennium Ecosystem Assessment supported by the UN, which remained the most comprehensive and complete program among those which have emerged in the field of ecosystem services.[9] The research program focused on the relation between social welfare and ecosystem services. We consider those goods, services and spiritual, aesthetic values provided by nature as ecosystem services which are used directly or indirectly by the human society.[10] The landscape functions usually refer to the goods and services provided by regions, landscapes, when researchers analyse next to the environmental issues the infrastructural, cultural and economic characteristics of land use systems as well.[11] The goods and services provided by landscapes can be distinguished by different methods, but usually these values are divided into three major groups: production/economic, ecologic/environmental and cultural (aesthetic, educational etc.) goods and services.

Several researches focus on the multifuncinality of the landscape, which concept explains the relation of landscape services and rural development. The research of Willemen and his research fellows underlined the trend that at multifunctional locations the total provided goods and services by the landscape were higher than at monofunctional sites[12] and similarly Braat and de Groot explored the relation between land use intensity and the level of ecosystem services highlighting the fact that extensive land use systems provide wider range and higher level of services.[13] However, in the Hungarian regional and rural development policy the development is defined by socio-economic indicators, and much less attention is paid for the utilization of the landscape values, features. Despite of this, in Hungary the National Rural Strategy (2012-2020) identifies the protection and sustainable use of landscape and natural values as key elements of the rural policy.[14]

The focus of several ecosystem services- and landscape function-related researches is on the measurement, clustering and mapping of the services/functions.[15,16] Following the same line, Herman et. al. emphasized,[17] that the analyses of the spatial distribution of the landscape functions is essential for reaching the appropriate landscape planning and landscape management decisions. Despite of the intensive and far-reaching researches, evaluations and mappings in this field, the landscape function concept has not built yet into the landscape planning and management practice properly.[18] But also Norgaard is the one who reminds us for the most important shortages of ecosystem service analysis which is that they are simplifying the real circumstances and cannot consider the impacts of human activities. That is why it is extremely important to consider the complexity and synergies of our ecologic and social systems.

Before clustering and typification of rural regions based on the levels of the different landscape functions, it is very important to explore the potential relationships, regularities among these landscape functions. The identification, measurement, and mapping of the landscape functions are mainly possible with different landscape indicators. According to Willemen et al.[19] these indicators are the

10 *de Groot, R.S. – Wilson, M. – Boumans, R. (2002): A typology for the description, classification and valuation of Ecosystem Functions. Goods Services Econ. Volume 41 Issue 3 pp. 393–408.*

11 *Bastian, O. (1997): Gedanken zur Bewertung von Landschaftsfunktionen – unter besonderer Berücksichtigung der Habitatfunktion, Schnevedingen, Germany: Alfred Toepfer Akademie für Naturschutz*

12 *Willemen, L., Hein, L., Mensvoort, M. E. F., Verburg, P. H. (2010): Space for people, plants, and livestock? Quantifying interactions among multiple landscape functions in a Dutch rural region. Ecological Indicators 10, 62–73. DOI: http://doi.org/10.1016/j.ecolind.2009.02.015*

13 *de Groot, Braat (2012): The ecosystem services agenda: bridging the worlds of natural science and economics, conservation and development, and public and private policy. Ecosystem Services Volume 1, Issue 1, pp. 4–15.*

14 *Ministry for Rural Development (2012): Nemzeti Vidékstratégia 2012–2020 (National Rural Development Strategy).*

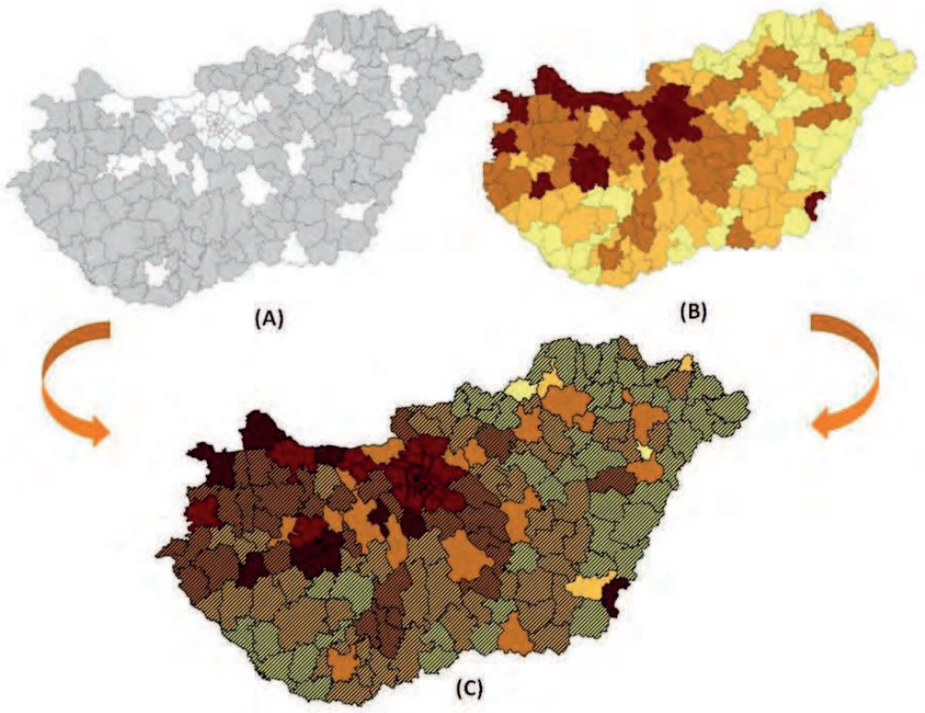
15 *Fisher, B., Turner, R. K., Morling, P. (2009): Defining and classifying ecosystem services for decision making. Ecol. Econ. 68, 643–653. DOI: http://doi.org/10.3410/f.1145051.602178*

16 *de Groot, R. S., Alkemade, R., Braat, L., Hein, L. és Willemen, L. (2010): Challenges in integrating the concept of ecosystem services and values in landscape planning management and decision making. Ecological Complexity 7, 260–272. DOI: http://doi.org/10.1016/j.ecocom.2009.10.006*

17 *Hermann, A., Kuttner, M., Hainz-Renetzeder, C., Konkoly-Gyuró, É., Tirászi, Á., Brandenburg, C., Allex, B., Ziener, K., Wrbka, T. (2014): Assessment framework for landscape services in European cultural landscapes: An Austrian Hungarian case study. Ecological Indicators 37 (A), 229–240. DOI: http://doi.org/10.1016/j.ecolind.2013.01.019*

18 *Norgaard, R. B. (2010): Ecosystem services: from eye-opening metaphor to complexity blinder. Ecol. Econ. 69, 1219–1227. DOI: http://doi.org/10.1016/j.ecolecon.2009.11.009*

19 *Willemen, L., Hein, L., Mensvoort, M. E. F., Verburg, P. H. (2010): Space for people, plants, and livestock? Quantifying interactions among multiple landscape functions in a Dutch rural region. Ecological Indicators 10, 62–73. DOI: http://doi.org/10.1016/j.ecolind.2009.02.015*



bases of the spatial identification of the landscape functions. Several sources can be used for the indicators: land covers (e.g. CORINE), or other economic, social and ecological databases.[20,21]

The number of the landscape indicators is endless; however, there are some collections of the most commonly used indicators. One of the most significant collections is the work of Cassatella and Peano.[22] In their system the indicators were divided into five groups: ecological, historical and cultural, economic, land use, and perceptional. We can find other significant collections focusing on the evaluation of the rural landscapes,[23] of the agro-environment,[24] or of the urban landscapes. In Hungary Kollányi made a collection of those landscape indicators, which are applicable in the Hungarian context.[25] In my research, I developed and chosen my indicators based on the formerly introduced systems, collections.

GOALS AND OBJECTIVES

The goal of the research is to identify the relationships between the landscape features, values and the socio-economic development in the case of the Hungarian rural regions.

The reach the goal the following research questions were defined:

1. Which are the most suitable landscape indicators to identify the landscape values, potential on the micro-regional level?
2. How can be clustered these landscape indicators? How can be built up this landscape indicator-system?
3. Is there any, and if so, what kind of relationship between the landscape features, values and the socio-economic development? What kind of normalities can be identified in the rural regions of Hungary?

MATERIALS AND METHODS

In Hungary the various development strategies and programs usually operated along the administrative borders, that is why the research was adjusted to these borders. 137 Hungarian micro-regions (so-called "járás") were involved in the research. These are the rural micro-regions according to the most common Hungarian rural threshold (the population density is below 120 persons/km²). Since the relationship between the landscape features and the socio-economic development was analyzed,

20 *Haines-Young, R., Watkins, C., Wale, C., Murdock, A. (2006): Modelling natural capital: the case of landscape restoration on the South Downs, England. Landscape and Urban Planning 75, 244–264. DOI: http://doi.org/10.1016/j.landurbplan.2005.02.012*

21 *Filepné Kovács, K. (2013): Tájhasználati szempontok vidéki térségek versenyképességének értelmezéséhez (Land use considerations related to the competitiveness of rural areas). Phd dissertation, Corvinus University of Budapest*

22 *Cassatella, C., Peano, A. (Eds.) (2011): Landscape indicators – Assessing and Monitoring Landscape Quality. Springer Dordrecht Heidelberg London New York*

23 *Piorr, H. P. (2003): Environmental policy, agri-environmental indicators and landscape indicators. Agricultural Ecosystem Environment 98, 17–33. DOI: http://doi.org/10.1016/S0167-8809(03)00069-0*

24 *LANDSIS g.e.i.e. (2002): Proposal on agri-environmental indicators PAIS. Project summary*

25 *Kollányi, L. (2004): Táji indikátorok alkalmazási lehetősége a környezetállapot értékeléséhez (Landscape indicator opportunities for the evaluation of the environment condition). CUB, Department of Landscape Planning and Regional Development, Budapest*

Indicator groups	Indicators
Environment–Biodiversity	1. Biological activity 2. Biodiversity 3. Environmental integrity 4. Forestry potential
Nature protection	1. Ecological network area 2. Internationally protected areas 3. Nationally protected areas 4. Other protected areas
Historical–Cultural	1. Number of cultural heritage 2. Historical significance
Visual–Perceptional	1.Landscape scenic value 2. Naturalness 3. Relief energy 4. Visual diversity
Agriculture	1. Agricultural potential 2. Soil
Tourism	1. Recreational potential 2. Tourist flow

Fig. 1: The Hungarian rural micro-regions (A), the micro-regions according to their socio-economic development (B), and the spatial relation between these two classifications (C)
Table 1: The 18 landscape-indicators in 6 groups

a complex socio-economic development indicator was also involved as the benchmark of this analysis, which was developed in 2007[26] (Figure 1).

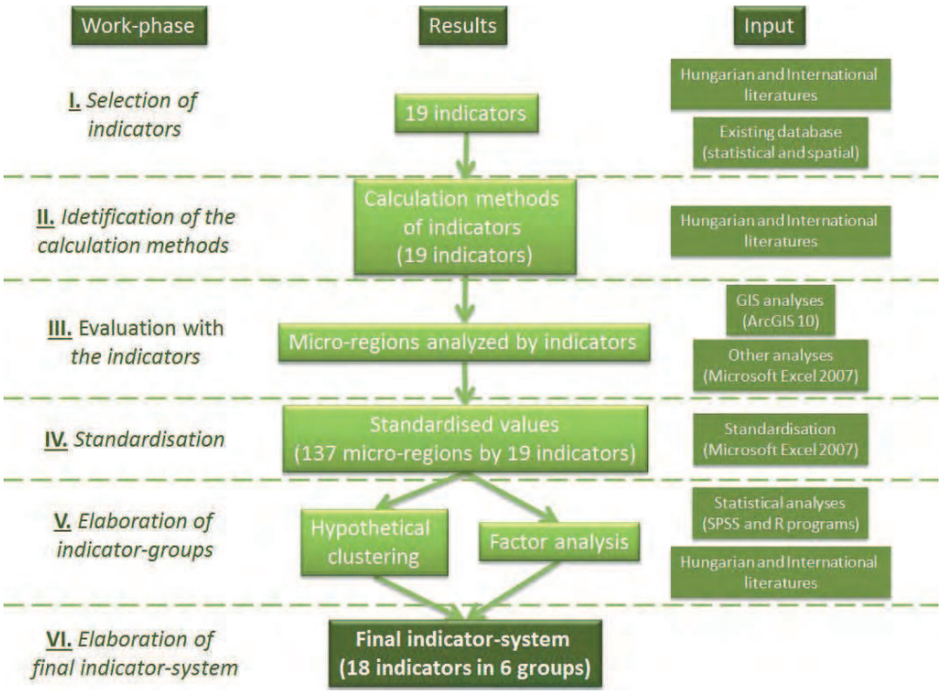
The elaborated landscape indicators provided the base of the evaluation, categorization of the rural micro-regions as well as the base of the comparison of the landscape values and the socio-economic development. Several sources and former researches were applied in order to create complex indicators, which were partly introduced in the Introduction part. The objective was to involve as many landscape-related indicators as possible from several fields; however, we did not strive to elaborate unique, special indicators. Thanks to the scale of the evaluation, our opportunities were limited by the availability of the data, the level of detail of the information, and the spatial homogeneity of the data. Some elements of the final indicator kit overlap with each other (e.g. the internationally protected areas often overlap the national protected areas), however, because of the relativity of the evaluation system (each micro-regions are evaluated relative to one another), this does not reduce the efficiency and relevance of the system. Furthermore, it is necessary to emphasize, that thanks to the complexity of the indicators, several important parameters do not appear in the names of the indicators, nevertheless they are included indirectly in the indicator-system (e.g. the various forms of the water are included in several indicators).

ArcGIS 10 and Microsoft Excel 2007 programs were used during the calculation of the indicators. The spatial analysis, calculations were carried out with the GIS program (e.g. cutting, length and area measurements, selections), while the Excel program was used to make the summaries of the data and information. During the next step the standardisation of the parameters was necessary, since they had been varying in totally different dimensions, scales.

To evaluate the level of the landscape functions, 18 complex landscape indicators were developed and used. The indicator-system was built up based on the literature reviews and professional consultations. In this system the indicators can be grouped into 6 groups (Table 1).

After the GIS-based evaluation various statistical methods were employed to identify the relationship among the landscape features and the socio-economic development. SPSS and R statistical programs were used to identify the correlations and the level of

26 *311/2007. (XI. 17.) Government Regulation*



them. During the correlation analysis the objectives are to detect the relationships between two or more indicators, and to identify the intensity of them. Therefore, in the general statistic the correlation means that two or more parameters are not independent. Despite of the formers, with this method it is not possible to justify cause and effect relationship, only the existence of the connection. We completed the analysis with significance testing, with which it can be justified, that the correlation is not only random (Figure 2).[27]

RESULTS

With the comparison of the landscape indicators and the socio-economic indicator our objective was to identify whether there is any relation between the landscape features and the socio-economic development. In the first phase all of the rural micro-regions of Hungary were involved into the research, while during the second phase two special Hungarian rural region-types were separately analysed (e.g. farmstead-type and small village-type micro-regions). In this part of the research the tourist flow was excluded, since it is already included in the complex socio-economic indicator, so with their correlation we cannot justify any new relationship.

The correlation analysis was carried out with 137 rural micro-regions. The reasons of the correlations, received during the statistical analysis, were identified according our professional judgement. The Figure 3 shows the summary of the correlation analysis.

The strongest relationship (significant correlation) was identified in the case of the recreational potential. We determined that the existences of the touristic primer infrastructure (e.g. bike paths, hiking trails), as well as the other favourable recreational potential (e.g. wine region) facilitate tourism profitability, and that is why they contribute to the development of certain micro-regions (the direction of the correlation is positive, that is why the values of the recreational potential and the values of the socio-economic indicator move in the same direction).

Similarly, significant correlation can be detected between the number of the cultural heritage and the socio-economic development (the direction of the correlation is also positive). If the analysis would have covered the urban regions of the country, this relation would be obvi-

27 *Fidy, J., Makara G. (2005): Biostatisztika (Biostatistic). InforMed 2002 Kft.*

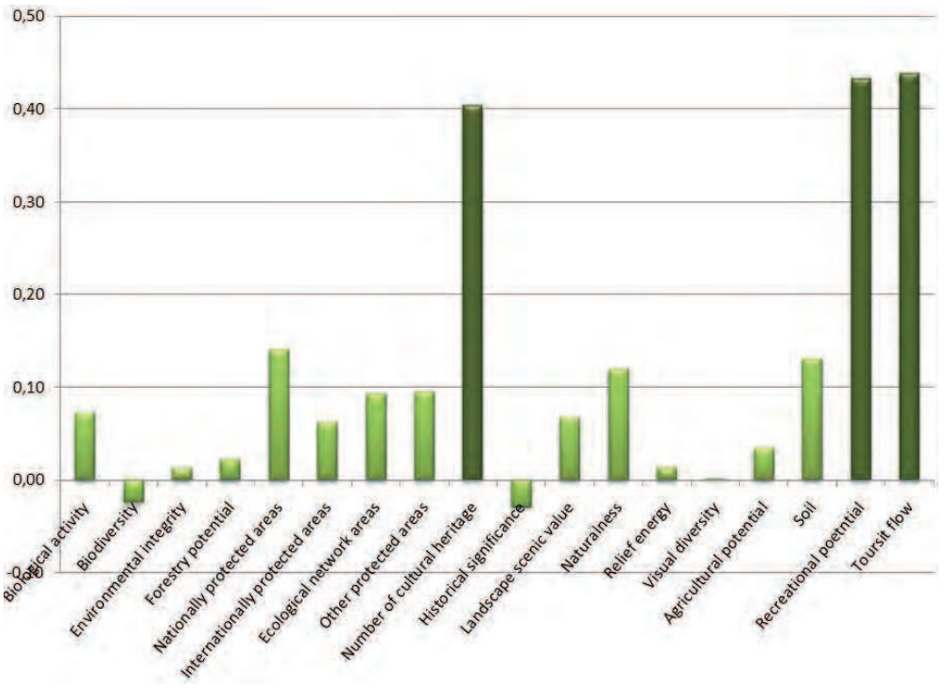


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Fig. 2 Process of elaboration of the indicator-system
Fig. 3. Correlation of the employed landscape indicators with the socio-economic indicator (dark green: landscape indicators with high correlation value)

ous, since in the bigger towns or cities the numbers of the cultural heritage are usually higher. Nevertheless, in the research we dealt only with the rural areas, it means, the bigger cities or urban areas were excluded from the sample area. Therefore, with the correlation between the economic development and natural heritage our research justified, that in general, those micro-regions are more developed economically, which have got significant cultural traditions and values. Consequently, the micro-regions, which are nowadays more developed, were in better position in the past as well, so my results show "historical determinism".

We could not identify any relationship with the socio-economic development in the case of the following indicator groups: Environment–Biodiversity, Nature protection, Visual–Perceptional, Agriculture. According to the results of the research we could not justify any relationship between the economic development and the quality of the environment in the rural areas of the country, so in general, the economically less-developed micro-regions do not have better environment quality.

The farmstead-type and small village-type micro-regions were defined based on the National Spatial Plan.[28] In this document 34 farmstead-type and 45 small village-type micro-regions are defined. The correlation analyses were carried out separately in these sample areas as well (Table 2). In the case of the small village-type regions, we received similar results as in the case of the national-wide analysis. In the case of the farmstead-type micro-regions, we could not justify relationship between the socio-economic development and the recreational potential, since the parameters included in this indicator (e.g. bike paths, hiking trails, wine regions) primarily concentrated in the hill countries of Hungary, so in the farmstead-type regions located in the plain areas of the country, these relations could not appear.

DISCUSSION AND CONCLUSION

In the research 18 complex landscape indicators were used, which were chosen according to the literature review, the former collections of landscape indicators, and the accessible country-scale, homogenized database. In the further research, the number of these indicators can be increased. To reach special objectives other, specified

28 *Office for National Economic Planning (2013): Országos Fejlesztési Koncepció és Országos Területfejlesztési Koncepció (National Development Conception and National Regional Development Conception).*

	Correlation value (absolut value)	
	Farmstead-type regions	**Small village-type regions**
Biological activity	0.1500	0.2000
Biodiversity	0.0810	0.0860
Environmental integrity	0.1030	0.0980
Forestry potential	0.0650	0.0230
Ecological network areas	0.3430	0.2400
Nationally protected areas	0.2230	0.3510
Internationally protected areas	0.3820	0.0620
Other protected areas	0.0520	0.2000
Number of cultural heritage	0.4690	0.5890
Historical significance	0.0850	0.0210
Landscape scenic value	0.2520	0.0100
Naturalness	0.3810	0.1960
Relief energy	0.0170	0.1430
Visual diversity	0.0160	0.1720
Agricultural potential	0.2180	0.1970
Soil	0.1430	0.2500
Recreational potential	0.2720	0.5560
Tourist flow	0.3010	0.5970

2

Table 2.:
Correlation of the employed landscape indicators with the socio-economic indicator in the case of the farmstead-type and the small village-type micro-regions

indicators can be also involved. The research was value-based, it means, that selected indicators measured the landscape values, however, in several cases the evaluation of the restrictive landscape values are also necessary.

In this research the general rules and relationships between the landscape features and the socio-economic development were explored. Researches in the future should focus on the clustering of the micro-regions based on the similar landscape features, values. These further works can be operated as guides for the preparation of the landscape management programs, strategies.

Any relationships were found only in 2 cases of the 18 employed landscape indicators, it means, that the connection between the landscape values and the socio-economic development is very weak in the Hungarian rural areas. Based on these, we can conclude, that the current rural development programs, strategies have not reached their objectives, since they do not deal in an appropriate manner with the landscape features, they are not area-specific and they do not utilize the landscape values properly. To reach a more effective rural development, better specified landscape management programs are needed, which build on the landscape features, values. These landscape management programs necessary to be integrated into the rural development system. ⊙

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ÖSSZEFOGLALÓ

FENNTARTHATÓ TÁJGAZDÁLKODÁST SZOLGÁLÓ TÁJINDIKÁTOR-RENDSZER

A vidéki térségek fejlesztésének alapját táji értékeik, tájpotenciáljuk jelentheti. A lehetőségek kiaknázása, kihasználása hosszú távon fenntartható módon a tájgazdálkodás során lehetséges. Hazánk vidéki területei nagyon eltérő adottságokkal rendelkeznek, ezért célzott, megfelelően specifikált programokra, stratégiákra van szükség.

Számos szakember hangsúlyozza, hogy a fenntartható tájgazdálkodáshoz első lépésben a tájfunkciókat kell pontosan meghatározni. A tájfunkciók gyakorlati tájgazdálkodásba integrálásához alapvető fontosságú a funkciók mérése és térképezése, mely elsősorban mutatószámokkal, tájindikátorokkal lehetséges. A vidéki térségek táji adottságok alapján történő tipizálása, csoportosítása előtt fontos azonban a szabályszerűségek, összefüggések feltárása. A kutatás fő célja e kapcsolatrendszerek detektálása, a gazdasági-társadalmi és a táji indikátorokra alapozott értékelések, osztályozások közötti viszonyrendszer azonosítása a magyarországi vidék esetében. A fő célhoz kapcsolódóan a következő kérdésekre kerestük a választ:

1. Melyek a legalkalmasabb tájindikátorok a táji értékek azonosítására térségi (járási) léptékben?
2. Hogyan csoportosíthatók a tájindikátorok? Hogyan építhető fel ez a táji alapú indikátorrendszer?
3. Van-e, és ha igen, akkor milyen kapcsolat van a táji adottságok, értékek és a gazdasági-társadalmi fejlettség között? Milyen szabályszerűségek azonosíthatók a vidéki Magyarország tekintetében?

Munkánk során értékalapú megközelítést alkalmaztunk, vagyis a tájindikátoraink elsősorban a tájpotenciál, a táji értékek azonosítására szolgálnak. A különböző fejlesztési programok, stratégiák még mindig közigazgatási egységek dimenziójában képesek hatékonyan operálni, ezért az értékelésünket is közigazgatási határokhoz igazítottuk.

A kutatás mintaterületét Magyarország vidéki járásai képviselik (120 fő/km² népsűrűség alatti járások). Ennek megfelelően az ország 198 járásából 137 képzi elemzéseink tárgyát. Viszonyítási alapként a 2007-es komplex gazdasági-társadalmi fejlettségi/fejletlenségi mutatót használtuk.

A vidéki járások értékelésének, kategorizálásának, valamint a társadalmi-gazdasági alapú mutatókkal való összevetésének alapját a táji indikátoraink szolgálták. A mutatók, valamint az azokból felépülő rendszer megalkotásához számos forrást használtunk. Célunk volt a tájjal kapcsolatos indikátorok lehető legszélesebb körű bevonása, ezzel szemben azonban nem törekedtünk speciális, egyedi mutatók megalkotására.

Összesen 18 komplex indikátort (148 változóval) határoztunk meg, amelyeket 6 csoportba rendeztünk:

- Környezet – Biodiverzitás csoport: Biológiai aktivitás; Biodiverzitás; Környezeti integritás; Erdészeti potenciál;
- Természetvédelem csoport: Ökológiai hálózatba tartozó terület; Nemzetközi jelentőségű védett terület aránya; Országos jelentőségő védett terület aránya; Egyéb védett terület;
- Történelmi – Kulturális csoport: Műemlékek száma; Történelmi jelentőség;
- Vizuális – Percepcionális csoport: Tájképi érték; Természetszerűség; Reliefenergia; Változatosság;
- Mezőgazdaság csoport: Agrárpotenciál; Talaj;
- Turizmus csoport: Üdülési potenciál; Idegenforgalmi áramlás.

A kutatás során a járás-alapú értékelések eredményeit harmonizáltuk, majd korrelációelemzéseket végeztünk.

Munkánk eredményeként azonosítottuk azon táji jellemzőket (műemlékek száma, üdülési potenciál), melyek összefüggésben állnak a gazdasági-társadalmi fejlettséggel. A környezeti, a természetvédelmi, valamint a vizuális csoportokba tartozó indikátorok és a gazdasági-társadalmi fejlettség között azonban nem igazolható az ország összes vidéki térségére általánosan érvényes korreláció.

Mindezek alapján elmondható, hogy azon térségek fejlettebbek, melyek gazdagabb történelmi-kulturális örökséggel rendelkeznek, vagyis hazánk vidéki területein egyfajta történelmi determináltság mutatkozik. Az alkalmazott 18 tájindikátor közül mindössze 2 esetben azonosítottunk valamilyen kapcsolatot a gazdasági-társadalmi mutatóval. Ezen eredmények alapján elmondható, hogy az ország vidéki részein általánosan nem terjedt el a táji adottságok, értékek hasznosítása, illetve az erre épülő tájgazdálkodás sem. A hatékony vidékfejlesztéshez tehát célirányosabb tájgazdálkodási programokra, illetve ezek vidékfejlesztésbe való integrálására van szükség.